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ABSTRACT

These materials are for use by elementary and middle school teachers in the state of Illinois. This document contains five modules for teaching water conservation. Topics include: (1) "Life Depends on Water," "What is Water?" and "The Hydrologic Cycle"; (2) "The Treatment of Drinking Water"; (3) "Wastewater Treatment"; (4) "Earth's Closed System/Water Pollution"; and (5) "IEPA and Environmental Laws/Illinois Rivers Appreciation Month." Each module contains student resources such as text, maps, handouts, and diagrams; classroom materials such as posters; and activities such as projects, experiments, games, and puzzles. In several modules, supplemental and extension activities are suggested. (CW)

WATER: THE LIQUID OF LIFE

Fifth Grade

(Materials may be duplicated for classroom/activity use)

Office of Public Information,
Division of Public Water Supplies and
Division of Water Pollution Control

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	Some Facts About Groundwater (Handout)
	The Hydrologic Cycle (Diagram)
	Water Usage (Handout)
	Dictionary of Environmental and Water Terms (Handout)
Classroom Materials	*The Hydrologic Cycle (Poster)*
	Water . . . Makes Life More Fun (Poster)
Activities	*Water's Going On?! (Project)*
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1

LIFE DEPENDS ON WATER

Don't take water for granted. You can't live without it. To begin with, your body is about two-thirds water. You need to take in about a quart of water a day to replace the water you lose naturally.

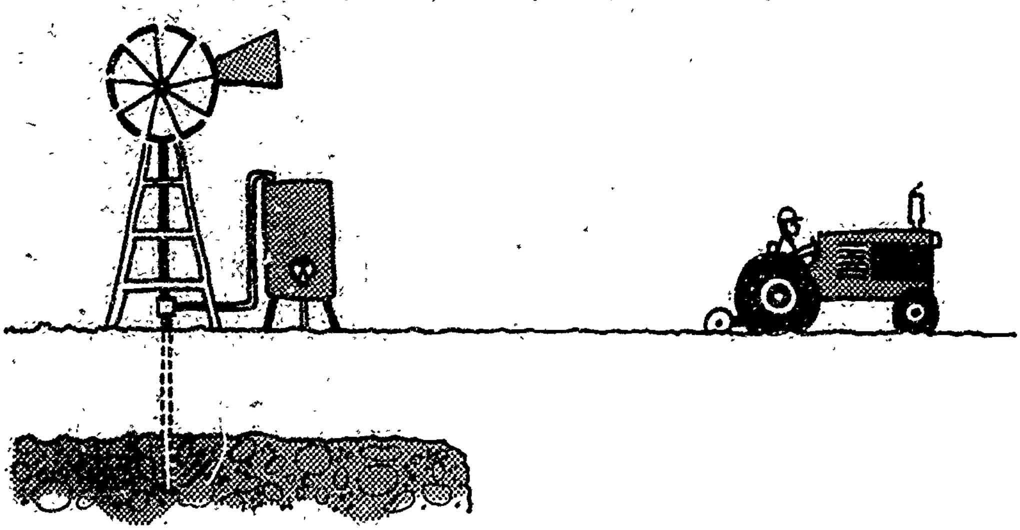
You need water for cleaning and gardening. Water is also needed to produce your food. Farmers depend on water to grow crops and raise animals. Believe it or not, it takes about 15 gallons of water to grow wheat for one loaf of bread, about 120 gallons to care for a chicken to lay one egg and about 4,000 gallons to produce a pound of beef.

Power plants use water for cooling. And factories use water to make the kinds of things you and your family use — things like clothing, paper, gasoline and steel for cars.

Ships carry goods and people around the world on water. People go swimming, boating and fishing in water. Many animals and plants live in water.

Most of the earth's water is salt water in oceans. Less than 1 percent of all the water on earth is usable fresh water — in lakes, rivers and underground aquifers.

The supply of fresh water is limited, and life is not possible without it. There is a constant amount of water on the earth. What does change is the form which water exists — liquid, solid, or gas. That means there is the same amount of water today as there was 100 years ago, or will be in 100 years. That is why it is important to keep water clean and usable.



WHAT IS WATER ?

Water is the only substance that occurs naturally on earth in three forms at the same time: as a solid, as a liquid and as a gas. Depending on the temperature and pressure, water may appear as steam, ice, snow, clouds and water vapor.

Chemically, water is known as H_2O. It freezes at 32°F (0°C) and boils at 212°F (100°C).

THE HYDROLOGIC CYCLE

Did you ever wonder where water comes from, where it goes and how it gets there? The people that know the answers to questions about water are hydrologists. **Hydrology** is the study of water.

In nature, water circulates endlessly through a system called the **hydrologic cycle**. The cycle begins when heat from the sun causes water to evaporate. This water comes from the land, lakes, rivers and especially the oceans. Plants are also a part of the cycle. After plants have taken water from the ground through their roots, it is passed out through their leaves by a system called **transpiration.** The sun-warmed water vapors rise into the atmosphere where the vapor is gradually cooled and condensed into water drops that form clouds, and eventually the moisture returns to earth as precipitation. There is as much water today as there ever was or ever will be. The water merely changes its form from solid to liquid to vapor and its location from the ocean, to the air, to the land and back again.

When it rains or snows, the precipitation becomes either groundwater or surface water. **Surface water** is the water we can see — streams, rivers and lakes. Some of the moisture that falls on the land evaporates, some runs off into streams and what is left soaks down into the soil. Water in the soil not used by plants is collected in the spaces between soil particles and fills the cracks and fractures in underground rocks. The special rock formations that hold and transmit water are called **aquifers** from two Latin words: *aqua* which means "water" and *ferre* meaning "to carry". The water in aquifers is referred to as **groundwater**, and the top of the groundwater level is the water table.

SOME FACTS ABOUT GROUNDWATER

■ Groundwater is underground. You cannot see it, but it is still very important.

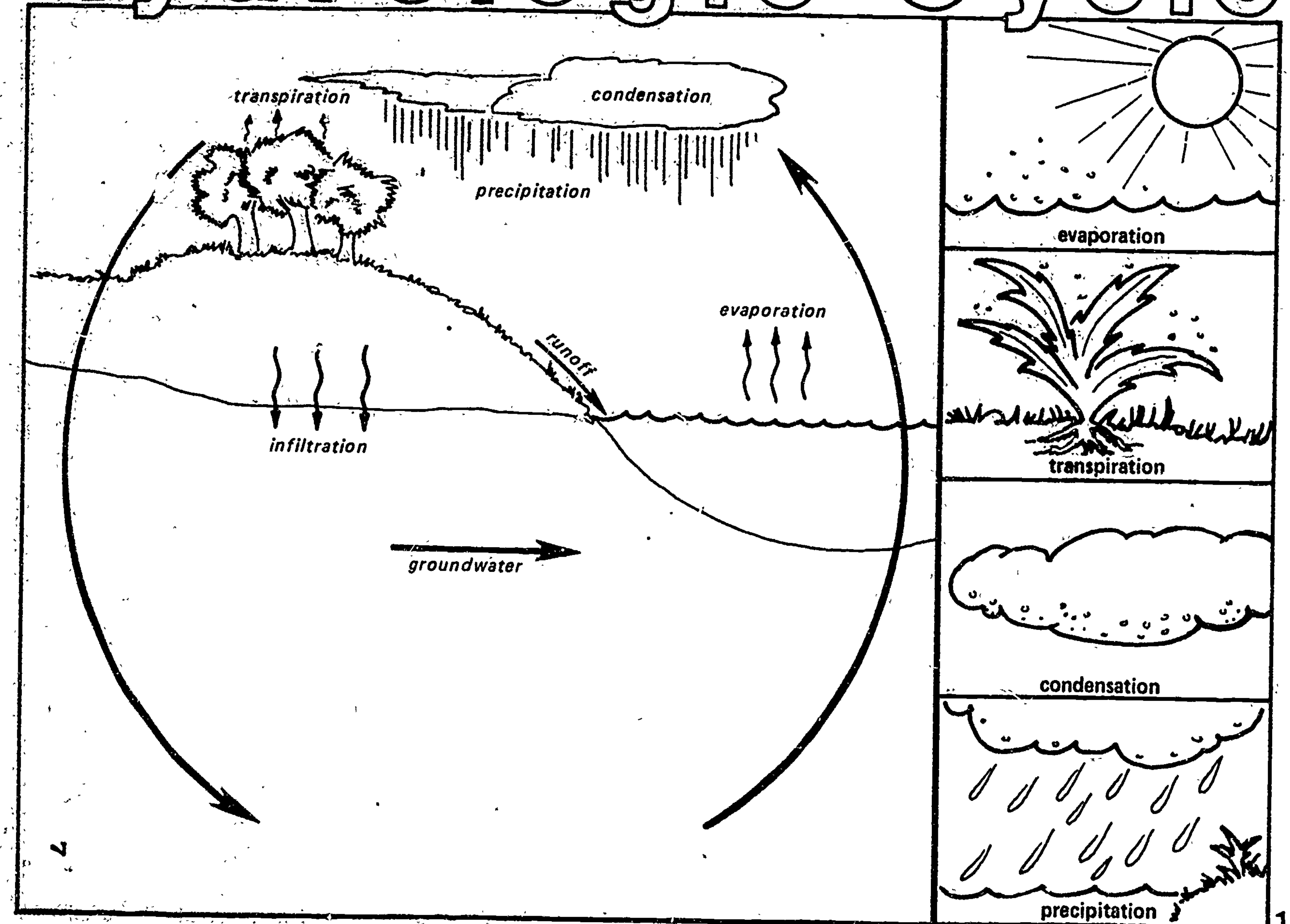
■ About half of all the people in the United States get their drinking water from groundwater sources.

■ Experts estimate that 90 percent of rural Illinois residents depend on groundwater drawn from wells as their primary water source.

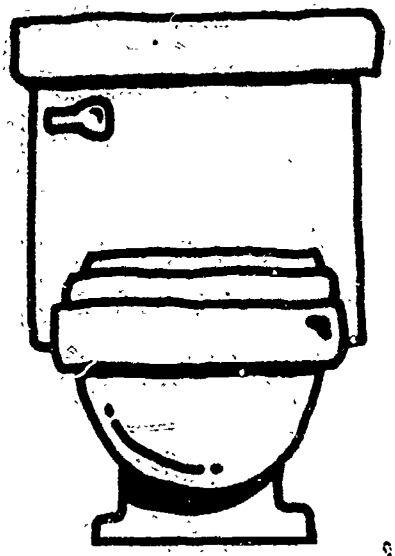
■ In the United States most groundwater is used for agricultural purposes like irrigation. Only 14 percent of the United States' groundwater is used for drinking.

■ Even though it is underground, groundwater is not protected from pollution. Dangerous chemicals that are on the surface of the land or buried underground can seep into groundwater and pollute it. Contamination can also come from mines, highway salts, fertilizers, abandoned oil wells, gasoline spills and dozens of other sources.

Hydrologic Cycle



How Much Water Does it Take?



5 to 7 gallons to flush a toilet

2 gallons to brush your teeth

2 gallons to wash your hands

5 to 10 gallons for every minute
you water your lawn or garden.

36 gallons to take a bath

25 to 50 gallons to take a shower

20 gallons to wash dishes by hand

10 gallons to use
an automatic dishwasher

A typical household in the United States uses 240 gallons a day.

Dictionary of Environmental and Water Terms

Acid Rain: Precipitation (rain, snow, sleet, or hail) which contains water more acidic than normal. Caused by reactions of chemicals in the atmosphere.

Aeration: A water-cleaning process in which the water is trickled through gravel.

Alum: A chemical which is used to remove harmful bacteria from water.

Aquifer: An underground layer of earth, gravel, or porous stone that contains water.

Ban: To prohibit, or not allow something.

Biodegradable: Able to be broken down into simpler products by microscopic plants and animals.

Chlorine: An element used for water purification.

Closed system: A system such as a spaceship or Earth in which energy, but not matter, can be exchanged with surrounding space.

Conservation: Avoiding waste of, and renewing when possible, the human and natural resources of the world.

Contaminate: To pollute something, or make it dirty.

Ecology: The study of relationships between living things and their surroundings.

Environment: Everything, including living things, that surrounds a person, animal, or plant.

Groundwater: The supply of water under the earth's surface that forms natural reservoirs.

Hydrologic cycle: The relationship between water and the earth caused by the pull of gravity and the heat of the sun. Also called the water cycle.

Hydrology: The study of water.

IEPA: Illinois Environmental Protection Agency.

Pollute: To make the land, water, or air dirty and unhealthy.

Potable: Drinkable.

Recycle: To reuse waste materials.

Reservoir: Large holding pool.

Resources: Air, water, soil, trees, plants, minerals, wildlife and other things that make up the natural wealth of the earth.

Runoff: Water from rain, melting snow, or irrigation that flows over the ground and returns to streams, sometimes carrying with it pollutants picked up from air or land.

Primary Treatment: In wastewater treatment: the first stage of treatment where all solids that sink or float are removed.

Saline: Salty

Secondary Treatment: In wastewater treatment: the second stage of treatment where sewage is mixed with air and sludge to increase the growth of bacteria that "eat" the organic pollutants.

Sediments: Soil, sand and minerals washed from land into water, usually by rain.

Seep: To leak slowly, as a liquid, through a porous substance such as soil.

Sewage: The organic waste and wastewater that comes from homes, farms and businesses.

Site: Place or location.

Sludge: Material found in wastewater treatment plants that is made up of tiny particles of solid wastes loaded with pollution-eating bacteria.

Tertiary: In wastewater treatment: a third stage of treatment to remove pollutants missed by primary and secondary treatment. Uses electrical, chemical, carbon filter and other cleaning techniques, and is the most expensive treatment.

Transpiration: The process by which plants give up water to the air through their leaves.

Treatment: Use of chemical, biological, or other processes to make waste less toxic or non-toxic.

Water Pollution: Water made unsafe to use because of sewage and other wastes that have been dumped untreated into it.

Wastewater: Water that carries solids, and that comes from homes, farms and businesses. (See "sewage.")

Water table: The depth below which the area of the ground is completely filled with water.

Wetlands: Water-soaked areas such as swamps, bogs, marshes and estuaries.

Project

WATER'S GOING ON?!

OBJECTIVES: Students will be able to: 1) record and interpret how much water they use in a day at school; and 2) make recommendations as to how they can save a significant percentage of that water.

METHOD: Students estimate and calculate water use in school, and then design and try ways to conserve water.

BACKGROUND: Every molecule of water that was present when the earth's oceans were formed is still present today in one of water's three forms — as a gas, a liquid, or solid. Water molecules move at varying speeds through the water cycle; water in its gaseous form may remain in the atmosphere for about nine days, but it may stay frozen in the Antarctic ice cap for up to 10,000 years.

Most of the fresh water in the world is frozen in these polar ice caps. The largest part of what remains is groundwater — underground water that moves between layers beneath the earth's surface.

In the United States, approximately half of the water used is drawn from groundwater sources. This amounts to approximately 82 billion gallons a day of groundwater. Much of the groundwater used will not be returned to the groundwater system in the near future. Shallow groundwater may have a renewal rate of about 300 years, and deep groundwater (over 1,000 meters deep) may renew itself in about 4,600 years.

This causes an ever-increasing drain on the groundwater supply. As groundwater dries up, stream flows are reduced. Ponds and marshes dry up and plant species die out. The groundwater remaining may also become contaminated by saltwater intrusion or by pollution, rendering it unfit to drink. All these results have obvious effects on wildlife, people and the environment.

A 1980 report from the U.S. Environmental Protection Agency states that groundwater depletion and contamination will be one of the major environmental problems of the 1980s.

Most of the world's fresh water is used for irrigation, but if a majority of Americans practiced personal water conservation and water quality practices, it would make a real difference.

The major purpose of this activity is for students to become aware of the amount of water they use and waste each day at school, and to make recommendations for ways to conserve water both at school and at home.

MATERIALS: Chalkboard, paper and pencils

PROCEDURE: 1) Ask the students to estimate how much water each student uses each day in school. Have containers of different volumes for students to use for reference. Write their estimates on the chalkboard or on a chart. A chart may be made showing the class's estimates as follows:

gallons	2	4	6	8	10	12
	x	x	xxx	xxx	xxx	xxx
	x	xxx	xxx	xx		
	x	xxx				

2) Ask the students to monitor their use of water for a day. They can time their drinks of water and record them in a notebook. Ask them to do the same for handwashing. They should also record the number of times they use the restroom, etc.

3) As a class, calculate the amount of water used; e.g., run water from the fountain to a container for 10 seconds and see how much water was used. Use this amount to calculate the amount per each drink that the students have recorded in seconds. Do the same for the sink faucets. Multiply the number of gallons used per flush by the number of trips to the restroom. Have each student come up with an individual number of gallons used.

4) Compare the estimates of water use to the actual water used.

5) Add all the individual gallons of water used to arrive at a total for the entire class. Divide this amount by the number of students in the class. This way, individual students can compare their individual usage against a class average to see if they are above or below average in their water use.

6) Ask the students if it would be possible to reduce the amount of water used, and if so, how. For example, cups could be used at the drinking fountain to reduce the amount of water that goes down the drain.

7) Put the student's suggestions into practice for a day or two. Then ask the students how water conservation practices changed what they did. What materials did they use or buy? Did their attitude change? How? Which changes in their behavior will they keep, as part of their personal lifestyles?

EXTENSIONS: 1) Where does water come from? How does it get here? Does our finding, transporting and using water affect wildlife in any way? If so, how? After a discussion of the effects of water depletion and conserva-

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tion on wildlife, ask students to draw two murals — one showing the effects of depletion and another the effects of conservation.
2) Monitor water use at home -- showers, dishes, clothes, washing, watering lawn, etc.
3) Use this activity for paper and energy use and conservation.
4) Incorporate use of elementary statistics in this activity!

EVALUATION:

- Estimate the number of gallons of water you use each day personally.
- What activity of yours requires the most water per year?
- Describe and explain three ways you can decrease your use of water.
- Describe and evaluate the seriousness of water problems you can identify which affect people and wildlife, now and in the future.

Name________________________

The Hydrologic Cycle

Directions: Fill in the blanks with these words. Each word may be used once.

Words to be used in filling in the blanks.

groundwater	**heat**	**vapor**
evaporate	**lakes**	**precipitation**
transpiration	**atmosphere**	**solid**
today	**liquid**	**moisture**
aquifers	**rivers**	**hydrologic cycle**

In nature, water circulates endlessly through a system called the ________________ ________. The cycle begins when _____ from the sun causes water to __________. This water comes from the land, _______, ________, and especially the oceans. Plants are also a part of the cycle. After plants have taken water from the ground through their roots, it is passed out through their leaves by a system called _______________. The sun-warmed water vapors rise into the _____________ where the vapor is gradually cooled and condensed into water drops that form clouds, and eventually the moisture returns to earth as ________________. There is as much water _________ as there ever was or ever will be. The water merely changes its form from _______ to ________ to _______ and its location from the ocean, to the air, to the land and back again.

When it rains or snows, some of the ____________ that falls on the land evaporates, some runs off into streams and what is left soaks down into the soil. Water in the soil not used by plants is collected in the spaces between soil particles and fills the cracks and fractures in underground rocks. The special rock formations that hold and transmit water are called ___________ from two Latin words: *aqua* which means "water" and *ferre* meaning "to carry". The water in aquifers is referred to as ________________.

Answer Key

The Hydrologic Cycle

Directions: Fill in the blanks with these words. Each word may be used once.

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groundwater	**heat**	**vapor**
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In nature, water circulates endlessly through a system called the **hydrologic cycle**. The cycle begins when **heat** from the sun causes water to **evaporate**. This water comes from the land, **lakes**, **rivers** and especially the oceans. Plants are also a part of the cycle. After plants have taken water from the ground through their roots, it is passed out through their leaves by a system called **transpiration**. The sun-warmed water vapors rise into the **atmosphere** where the vapor is gradually cooled and condensed into water drops that form clouds, and eventually the moisture returns to earth as **precipitation**. There is as much water **today** as there ever was or ever will be. The water merely changes its form from **vapor** to **liquid** to **solid** and its location from the ocean, to the air, to the land and back again.

When it rains or snows, some of the **moisture** that falls on the land evaporates, some runs off into streams and what is left soaks down into the soil. Water in the soil not used by plants is collected in the spaces between soil particles and fills the cracks and fractures in underground rocks. The special rock formations that hold and transmit water are called **aquifers** from two Latin words: *aqua* which means "water" and *ferre* meaning "to carry". The water in aquifers is referred to as **groundwater**.

Module 2: The Treatment of Drinking Water

Student Resources

"A Glass of Cold, Sparkling Water," "Where Does Our Drinking Water Come From?" and "What Happens to Water Before it Comes Out of the Faucet?" (Text)

Drinking Water Treatment Process (Diagram)

Drinking Water Milestones (Handout)

Activities

Measuring Your Family's Water Usage (Project)

Hard Water? Soft Water? (Experiment)

Additional Activities For and Outside the Classroom (Projects)

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A GLASS OF COLD, SPARKLING WATER

Safe drinking water is a blessing many people take for granted. It's easy to see why. What could be more simple than turning on the tap and getting a drink of water? But behind each gallon, behind each drop is the effort of scientists, engineers, legislators, water plant operators and regulatory officials. It is their job to keep this resource clear, clean and safe.

Our drinking water supply comes from two sources — groundwater and surface water. Groundwater comes from the reserves of water hidden beneath the earth in aquifers. Surface water is rivers, streams and lakes.

WHERE DOES OUR DRINKING WATER COME FROM?

At first, many early settlements were near large surface water sources. However, these communities became crowded and people were forced to move away from rivers and lakes.

The people who lived away from lakes and rivers needed a good, clean and readily available supply of water. To get a steady supply of water, people dug wells. For hundreds of years, people dug wells by hand. Today, most people don't dig wells by hand. Instead, they use powerful drills to dig wells. Most people who live in the country get their water from wells.

WHAT HAPPENS TO WATER BEFORE IT COMES OUT OF THE FAUCET?

Nearly 2,000 public water supply systems deliver over 1.77 billion gallons of safe, clean drinking water to Illinois water consumers each day. The ma-

jority of public water supplies pump water from wells for treatment and distribution to consumers. The largest percentage of the population consumes surface water, due to the large number of people in the Chicago metropolitan and suburban areas who receive treated water from Lake Michigan.

Thousands of workers at modern water treatment plants maintain the quality of our drinking water supply. The drinking water treatment process can be broken down into seven steps. Here is how a water treatment plant works:

INTAKE: Water from a surface source, or a river is drawn into a treatment plant. Intake screens strain out large debris such as fish, sticks and plants. If the source is groundwater, the screening process is done by nature because the water is clean from traveling through layers of sand and rock.

PRE-TREATMENT: Chemicals such as chlorine, alum and lime are added to the water to remove impurities, soften the water and destroy bad tastes, colors and odors. Excess lime can also be added to remove minerals from the water which leave deposits called scale.

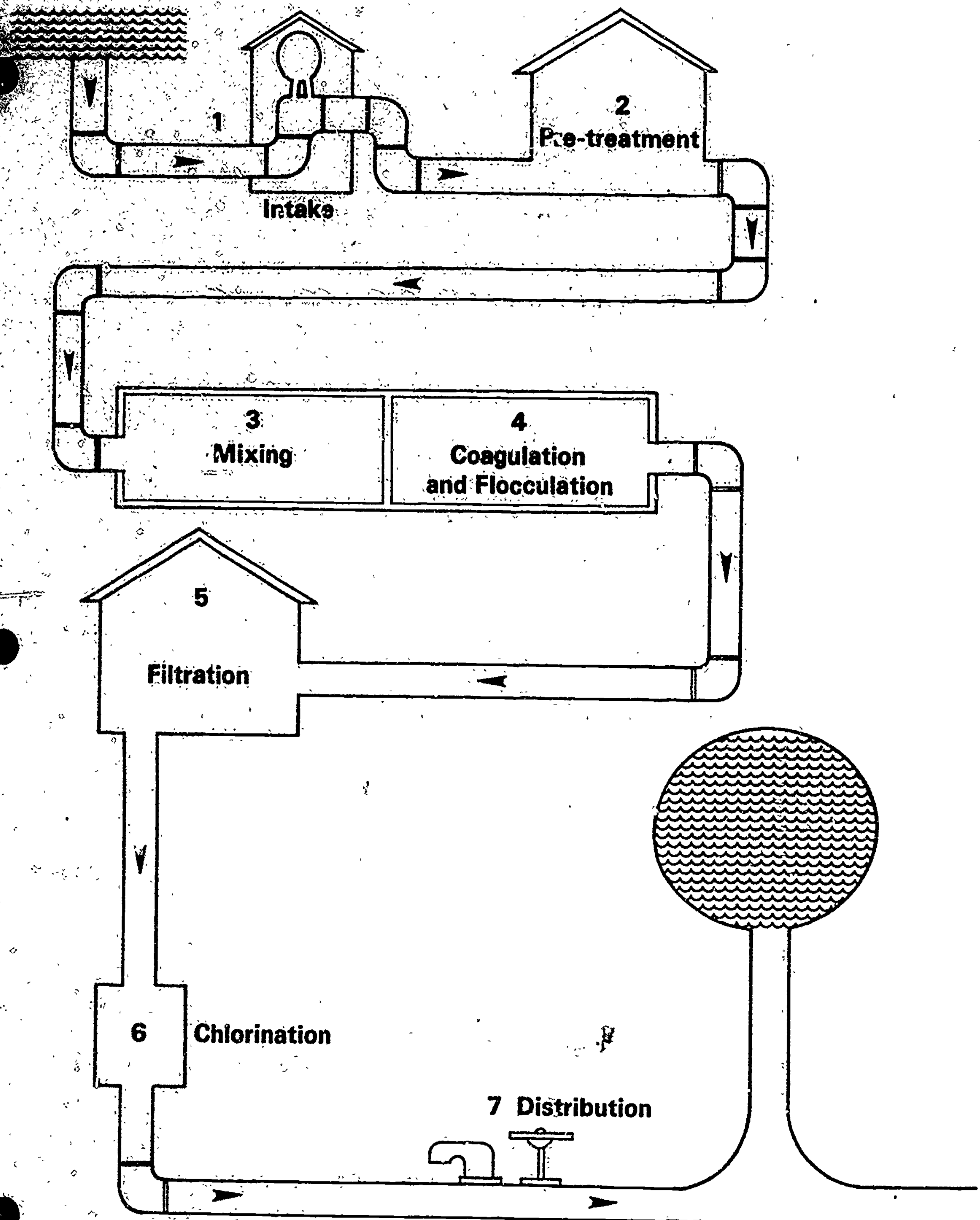
MIXING: The water is then stirred by mechanical mixers. The mixers stir the chemicals through the water.

COAGULATION & FLOCCULATION: The water then travels to a large basin. The chemicals cling to the impurities in the water **(coagulation)**, forming large, heavy particles. These particles are called **floc**. These large particles become heavy and settle to the bottom of the sedimentation tank.

FILTRATION: From the sedimentation basin where most of the floc has settled to the bottom, the water travels through sand beds which filters the water to remove any remaining impurities.

CHLORINATION: Chlorine is added to kill bacteria and keep the bacteria from growing as the water travels to the consumer. Most water treatment plants also add flouride at this point.

DISTRIBUTION: After the water is clean, it is stored in an elevated tank, stand pipe, or covered reservoir. The water then travels through large pipes called mains to houses, schools and businesses.



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The Drinking Water Treatment Process

DRINKING WATER MILESTONES

2000 BC: Sanskrit manuscript observes that "It is good to keep water in copper vessels, to expose it to sunlight, and filter it through charcoal."

Circa 400 BC: Hippocrates emphasizes the importance of water quality to health and recommends the boiling and straining of rainwater.

1832 AD: The first municipal water filtration works open in Paisley, Scotland.

1849: Dr. John Snow discovers that the victims of a cholera outbreak in London have all used water from the same contaminated well in Bond Street.

1877-1882: Louis Pasteur develops the theory that disease is spread by germs.

1882: Filtration of London drinking water begins.

1890s: The Lawrence Experiment Station of the Massachusetts Board of Health discovers that slow sand filtration of water reduces the death rate from typhoid by 79 percent.

Late 1890s: The Louisville Water Company innovates by combining coagulation with rapid sand filtration. This treatment technique eliminates turbidity and removes 99 percent of bacteria from water.

1908: Chlorination is introduced at U.S. water treatment plants. This inexpensive treatment method produces water 10 times purer than filtered water.

1912: Congress passes the Public Health Service Act, which authorizes surveys and studies of water pollution, particularly as it affects human health.

1914: The first standards under the Public Health Service Act are promulgated. These introduce the concept of maximum permissible safe limits for drinking water contaminants. The standards, however, apply only to water supplies serving interstate means of transportation.

1948: Congress approves a Water Pollution Control Act.

1972: The Clean Water Act, a major amendment to the Federal Water Pollution Act, contains provisions for restoring and maintaining all bodies of surface water in the U.S.

1974: The Safe Drinking Water Act is passed, greatly expanding the scope of federal responsibility for the safety of drinking water.

1977: The Safe Drinking Water Act is amended to extend authorization for technical assistance, information, training and grants to the states.

1986: The Safe Drinking Water Act is amended. Amendments set mandatory deadlines for the regulation of key contaminants; require monitoring of unregulated contaminants; establish benchmarks for treatment technologies; bolster enforcement powers; and provide major new authorities to promote protection of groundwater resources.

Reprinted from EPA Journal, 9/86.

More Water Facts

- In Ancient Egypt, water was siphoned from large jars after particles from the Nile River had settled to the bottom.
- The Chinese were the first to discover that water can be purified by boiling.
- The ancient Romans built aqueducts to transport water from the mountain springs to Rome. Some of these structures are still used today!
- Wells were the first public water systems.
- In the 1850s, scientists first began to suspect that disease could be transmitted by water.
- The first water pipes in the United States were made of bored or fire-charred logs.
- The first complete water distribution system in the United States was in Winston-Salem, N.C.
- The first successful water filtering system was installed at Poughkeepsie, N.Y. in 1872.
- In 1892, the world witnessed the purifying effects of filtering water. An epidemic of cholera struck the city of Hamburg, Germany. The citizens caught the disease from drinking water from the polluted Elbe River. Across the river, the citizens of Altona, Germany didn't catch the deadly disease because they filtered the water from the river.
- In 1902, Belgium was the first country to use chlorine to kill germs in the drinking water supply. Chicago and Jersey City were the first cities in the United States to add chlorine to their drinking water.

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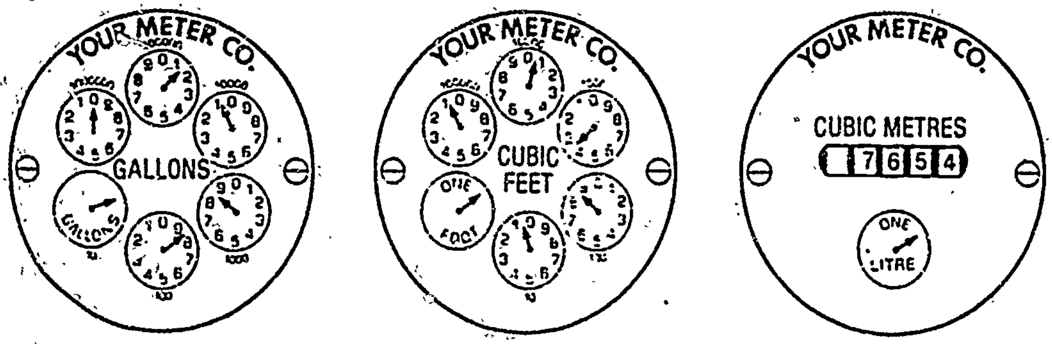
Project

MEASURING YOUR FAMILY'S WATER USAGE

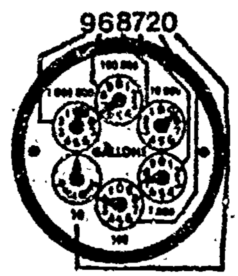
OBJECTIVE: To measure your family's water usage.

MATERIALS: Paper, pencil

PROCEDURE: Find the water meter in your home. Record the figures every day for a week to see how much water your family uses. Your home's water meter may look like either of the three diagrams:



How you read your water meter depends on its type. To read a water meter that records your family's water usage by cubic feet, multiply the number appearing on the water meter by 7.5 to find the number of gallons used. If the water meter is a circular-style meter, read each dial counter clockwise to find the total.



EXTENSIONS: Try to think of ways your family can conserve water.

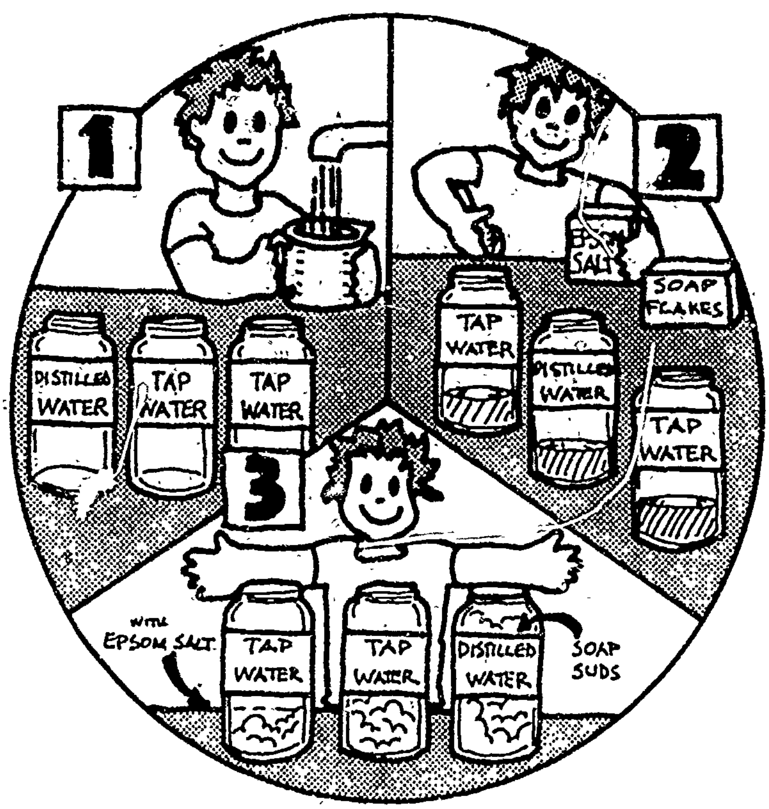
Experiment

HARD WATER? SOFT WATER?

OBJECTIVE: To test the effects of minerals in water.

MATERIALS: Cold tap water, three jars with lids, distilled water, measuring spoons, measuring cup, Epsom salt, soap flakes (not detergent), masking tape, pencil

PROCEDURE: 1) In two jars, put a half cup of cold tap water in each. 2) In a third jar, put a half cup of distilled water. Distilled water is as soft as water can get. 3) In one of the two jars containing cold tap water, put a half teaspoon of Epsom salt. Label the jar. Put on the lid and shake the jar to mix the Epsom salts. *You have just made hard water!* 4) Now put a half teaspoon of soap flakes in each jar. Put on the lid and shake each jar five times.



EVALUATION:
- ☐ In which jar is the foam most sudsy?
- ☐ Which jar has the least amount of suds?
- ☐ Compare how soft your tap water is against the distilled water and the hard water you made.

ADDITIONAL ACTIVITIES FOR AND OUTSIDE THE CLASSROOM

■ Make an exhibit for your school or library showing how drinking water is treated and distributed.

■ Find out where your community gets its water supply. Is it from surface or underground sources?

■ Visit your community's water treatment plant.

■ Check to see how many major cities in Illinois are beside large lakes or rivers. Name the cities. How many major cities can you find along the entire Mississippi River? Around the Great Lakes? Along the Illinois River? Along the Ohio River?

Module 3: Wastewater Treatment

Student Resources	*"Wastewater Treatment," "Primary Treatment," "Secondary Treatment," "Tertiary Treatment" and "The Stuff That's Left Behind" (Text)*
	Wastewater Treatment (Diagram)
Classroom Materials	*From Sink to Stream: The Wastewater Treatment Process (Poster)*
Activities	*Water Treatment (Experiment)*
	Aeration (Experiment)
	Additional Activities For and Outside the Classroom (Projects)
	The Blue Persuasion Crossword Puzzle

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WASTEWATER TREATMENT

Treatment of wastewater is a relatively modern practice. Even though, sewers to remove foul-smelling water were common in ancient Rome, it was not until the 19th century that large cities realized that they had to reduce the amount of pollutants being discharged into the water. Despite large supplies of fresh water and the natural ability of water to cleanse itself over time, populations had become so concentrated by 1850 that outbreaks of life-threatening diseases were traced to bacteria in the polluted water.

Since that time, the practice of wastewater collection and treatment has been developed and perfected, using some of the most technically sound biological, physical, chemical and mechanical techniques available. As a result, public health and water quality are protected better today than ever before.

The modern sewer system is an engineering marvel. Homes, businesses, industries and institutions throughout the modern world are connected to a network of below-ground pipes which transport wastewater to treatment plants before it is released to the environment. Wastewater is the flow of used water from a community.

At a typical wastewater plant, several million gallons of wastewater flow through each day -- 50 to 100 gallons for every person using the system. The amount of wastewater handled by the treatment plant varies with the time of day and with the season of the year. In some areas, the flow during particularly heavy rains or snow melts can be much higher than normal, particularly in communities without separate sewer systems for wastewater and runoff from rainfall.

The typical wastewater treatment plant uses a series of treatment stages to clean up the water so that it will be safe. Treatment usually consists of two major steps, primary and secondary treatment, along with a process to dispose of solids (sludge) removed during the two steps.

PRIMARY TREATMENT

In primary treatment, large solids are removed from the wastewater. Sand, grit and the larger solids in the wastewater are separated from the

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liquid. Devices such as grit chambers, bar screens and settling tanks are commonly used to separate the waste from the liquid. Primary treatment removes 45 to 50 percent of the pollutants.

SECONDARY TREATMENT

After primary treatment, wastewater still contains solid materials floating on the surface. Most public wastewater treatment plants now provide a second stage of treatment known as secondary treatment to remove up to 85 percent more of the pollutants. Secondary treatment is largely a biological process. Air is supplied to stimulate the growth of bacteria and other organisms to consume most of the waste materials. This process is known as **aeration**. The wastewater is then separated from the organisms and solids, disinfected to kill any remaining harmful bacteria and released to a nearby lake, river, or stream.

TERTIARY TREATMENT

An even better level of treatment, third stage, or tertiary treatment is needed in some instances. Tertiary treatment includes additional removal of solids and man-made chemicals.

Filtration is used to remove particles that the first two stages of treatment could not. Wastewater passes through several types and sizes of granular materials such as fine sand and coal. Filters catch the unwanted particles. During this stage, chemicals like chlorine are also added to disinfect the water, killing any disease-causing organisms that might remain.

More communities are now using tertiary treatment to provide additional protection for lakes and streams.

THE STUFF THAT'S LEFT BEHIND

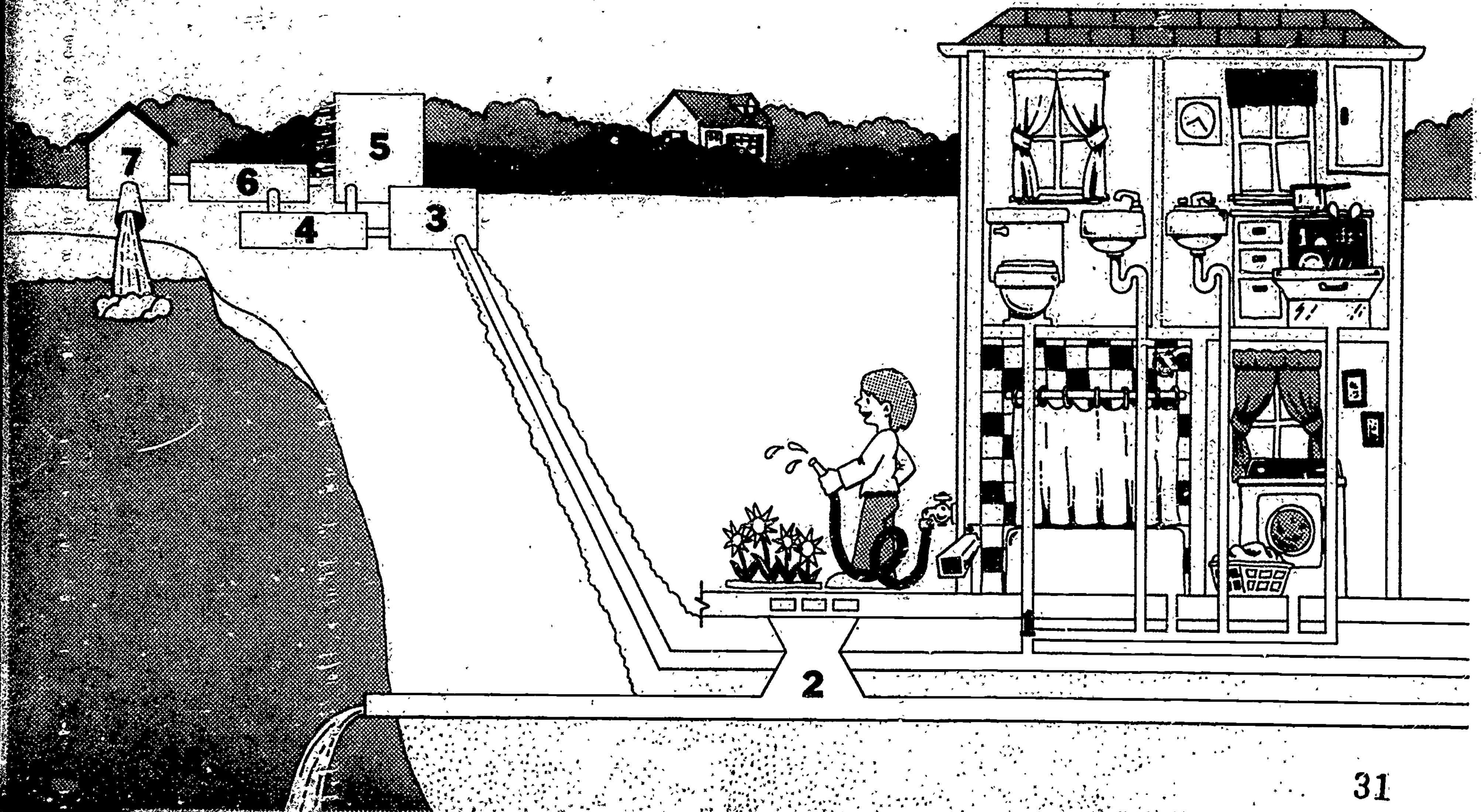
You may have figured out by now that while treatment of wastewater solves one problem — cleaning the water that is released from the treatment plant to the stream — it also generates a large amount of organic material that has been removed from wastewater. This material is called **sludge**. Sludge requires proper treatment and disposal, and can often be reused. Sludge handling methods are designed to remove excess water and destroy harmful organisms. The end product of the sludge handling

process is a relatively dry material known as "cake". It can be applied to agricultural land as a soil conditioner, placed in landfills, or cleanly burned. At some plants, sludge processing produces a gas (methane) that can be used as a fuel for plant operations.

1. Indoor pipes carry wastewater from the drains to underground sanitary sewer pipes. The water then goes to a sewage treatment plant.
2. Runoff from roofs, ground and streets goes into a street drain that leads to a storm sewer which empties into nearby waterways.
3. Wastewater travels into the screening house where all the large waste particles are trapped.
4. The water then goes to a sedimentation tank where grit and gravel sink to the bottom.
5. In secondary treatment, the water is pumped into an aeration tank where it is mixed with air for several hours.
6. The water goes to a second sedimentation tank to settle the sludge. Sludge is particles of solid waste left after treatment.
7. Chlorine gas is then pumped into the water. The chlorine kills germs that cause disease. Treated water is then released to the waterway.

From Sink to Stream:

Following the Wastewater Treatment Process



The Blue Persuasion Crossword Puzzle

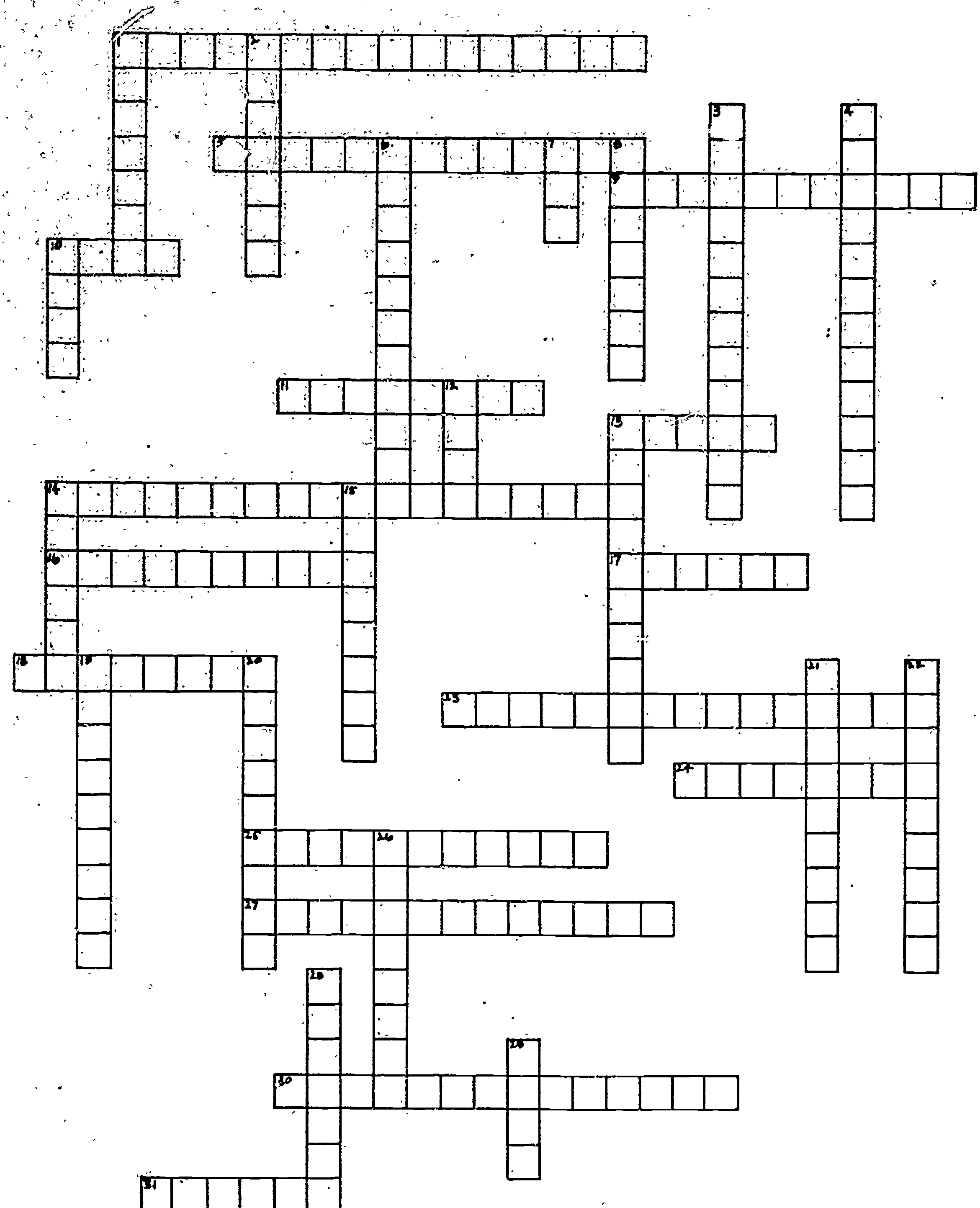
ACROSS

1. The first stage of wastewater treatment.
5. Can be broken down quickly into a gas or liquid by microscopic plants and animals.
9. To pollute something.
10. To leak slowly.
11. A water-cleaning process in which water is trickled through gravel.
13. The liquid of life.
14. The stage of treatment where sewage is mixed with air and sludge.
16. Water that carries solids.
17. Water that flows over the ground and returns to streams, sometimes carrying with it pollutants picked up from air or land.
18. Water-soaked areas.
23. The water cycle.
24. Used for water purification.
25. Everything that surrounds a person, animal, or plant.
27. The process where plants give up water to the air through their leaves.
30. Water made unsafe to use because of sewage and other wastes that have been dumped into it.
31. Material found in wastewater treatment plants that is made up of tiny particles of solid wastes.

DOWN

1. To make the land, water or air dirty and unhealthy.
2. An underground layer of earth, gravel, or porous stone that contains water.
3. A natural spring.
4. Not wasting natural resources.
6. Water under the earth's surface that forms natural reservoirs.
7. To prohibit, or not allow, something.
8. The relationship between living things and their environment.
10. A place or location.
12. Abbreviation for Illinois Environmental Protection Agency.
13. The depth below which an area of the ground is completely filled with water.
14. The organic waste and wastewater that comes from homes, farms and businesses.
15. The final stage of wastewater treatment.
19. Processes to make waste less toxic or non-toxic.
20. Soils, sands and minerals washed from the land into water, usually after rain.
21. The study of water.
22. Large holding pool.
26. Air, water, soil and other things that make up the natural wealth of the earth.
28. Drinkable.
29. A chemical used to remove bacteria from water.

Blue Persuasion Crossword Puzzle



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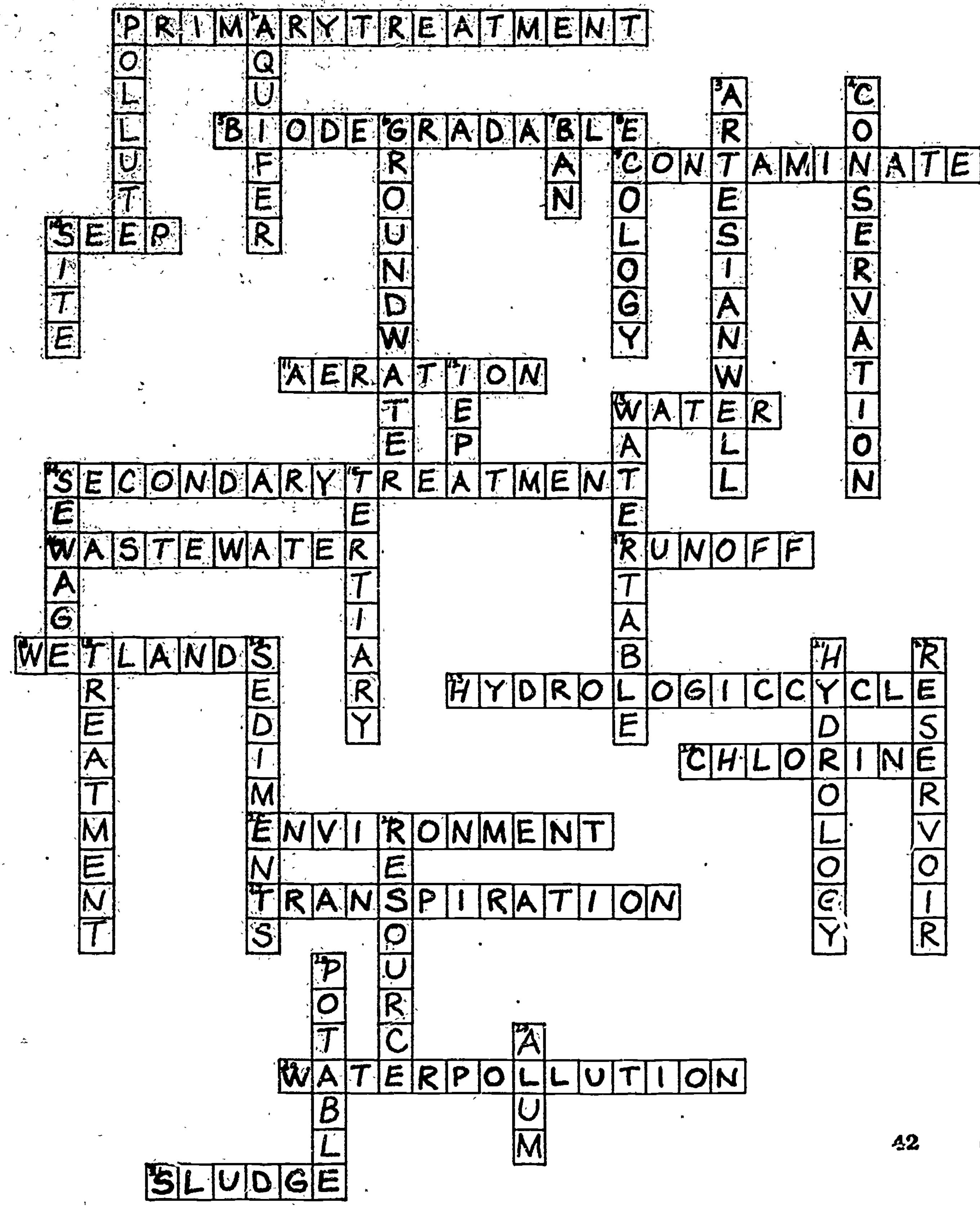
Answers to the Blue Persuasion Crossword Puzzle



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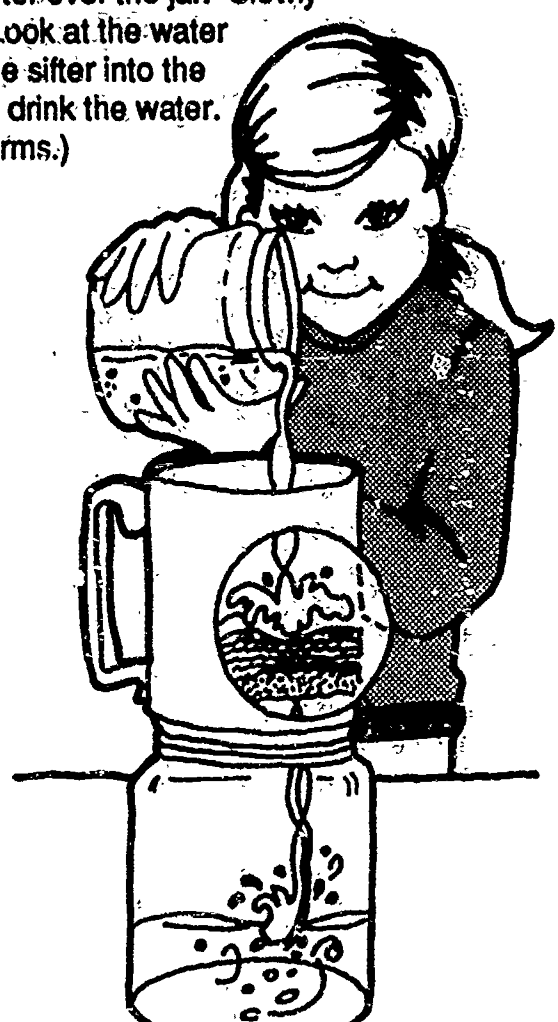
Experiment

WATER TREATMENT

OBJECTIVE: To learn more about how water is treated by cleaning it yourself.

MATERIALS: A flour sifter or homemade container with a screen bottom; absorbent cotton; coarse, clean sand; clean gravel; a large glass jar; and muddy water

PROCEDURE: Cover the screen at the bottom of the sifter or container with a layer of cotton, next a one-inch layer of the coarse sand, then a one-inch layer of the gravel. Set the sifter over the jar. Slowly pour muddy water into the sifter. Look at the water when it comes out the bottom of the sifter into the jar. Is it still muddy? (Note: Don't drink the water. It may look clean, but it still has germs.) Compare what you did with what wastewater treatment plants do.



Experiment

AERATION

OBJECTIVE: To observe how water is mixed with air during the wastewater treatment process.

MATERIALS: A see-through jar with a lid, liquid (i.e., fruit juice)

PROCEDURE: Fill the jar three-fourths full with the liquid. Shake the bottle several times. The liquid should mix with the air at the top of the bottle.

EVALUATION:

■ What appears on the top of the liquid? The foam or bubbles are the result of mixing the liquid with air.

Projects

ACTIVITIES OUTSIDE THE CLASSROOM AND SCHOOL

■ Do you waste water in your home? Wasted water flows into sewers and must be cleaned all over again. Make a list of ways you and your family can save water.

■ Make an exhibit for your school or library showing how wastewater is treated in your community.

■ Visit a wastewater treatment plant in your community.

■ Visit a construction site or a gas station after a heavy rain. Look at the ground to see if the rain has washed dirt away from the site, or oil away from the gas station, into the street. Find out where the runoff, dirt, or oil goes, and if anything can be done to stop the runoff.

Module 4: Earth's Closed System/Water Pollution

Student Resources	*"Earth is a Closed System," " What is Water Pollution," "Water Pollution Sources" and "How Much Is Too Much? " (Text)*
	Earth's Closed System (Diagram)
Activities	*Toxics and Living Things (Experiment)*
	Water Makes Headlines (Project)
	Word Find (Activity/Answer Key)
	Additional Activities For and Outside the Classroom (Projects)

4

EARTH IS A CLOSED SYSTEM

Earth is sealed off from space much as a spaceship is. Earth's land, water and air are locked together by gravity and cannot drift off separately into space. All of the fresh water, air and mineral resources Earth now has, it has always had. Earth gets no new supplies from space.

The water you drink today may contain atoms drunk by dinosaurs millions of years ago. And your favorite person in history may have breathed some of the air you are breathing now.

Earth is a closed system. Recycling of resources such as water and air is vital in closed systems. Without recycling, water and air would soon be used up in a closed system.

Although new water and air do not enter the Earth's closed system, energy in the form of sunlight does reach us. Sun energy provides the power for recycling by nature.

Wood, wool, cotton and other materials produced by living things are broken down into atoms when eaten by insects, bacteria and fungi. The atoms are recycled into new materials. For example, the atom may become mineral matter dissolved in water that plants soak up through their roo'.

But some materials that are made in laboratories by people cannot be recycled by nature. These man-made materials include many plastics, detergents and chemicals. They cannot be eaten by insects, bacteria, fungi, or any other living things. Thrown away in the trash, dumped into water or carelessly sprayed in the air, these man-made materials are not destroyed. Instead, they remain often poisoning the environment and becoming pollutants.

There are still other materials, such as iron, copper and glass, that are recycled in nature, but very slowly. These materials must be dissolved in water before living things can absorb them. And it may take many years before they are dissolved. The cans and junk cars that litter our countrysides are examples of the environmental problems caused by slowly dissolving materials. They are also pollution.

People can help to protect the environment from manmade materials that cannot be destroyed and materials that are only slowly dissolved by nature. To help, you must learn as much as you can about pollution problems.

WHAT IS WATER POLLUTION?

Water is polluted when it is unsafe to use because untreated sewage and other wastes have been dumped into it. Polluted water can smell, have garbage floating in it, look muddy and be too ugly to swim or boat in. But even water that looks clean and smells good can be polluted: it may be loaded with germs and dangerous chemicals that you cannot see.

People pollute water in a lot of ways. One way is to allow factory and bathroom wastes to flow through pipes and into waterways with no treatment. Another way is to allow soil, fertilizers and pesticides to wash from farms. Soils can be washed from building and mining sites into waterways after a rain.

Bacteria can feed on some wastes. Other wastes will be diluted by water in waterways. But nature can only do so much!

WATER POLLUTION SOURCES

In the United States, pollution is the main reason that fresh water supplies have decreased. Today, many toxic and potentially dangerous chemicals threaten the cleanliness of our water supply. Although these chemicals can be useful in industry and agriculture, they can pose a health risk even in small concentrations. Chemicals can enter our drinking water supply from pesticides, herbicides and fertilizers used in agriculture, dump and landfill sites, leaking underground storage tanks, industries and mining and petroleum operations.

Pollutants can be bacteria and other organisms found in human and animal waste that cause diseases such as cholera, or toxic metals such as mercury and lead that cause serious health problems such as cancer and birth defects. Organic chemicals, phosphorus and other toxic substances may pollute our water supply.

HOW MUCH IS TOO MUCH?

Today, scientists can measure smaller amounts of toxic substances than ever before.

Suppose you accidentally spilled a few drops of orange juice into a large swimming pool. After a few hours, the few drops of juice would be spread throughout the thousands of gallons of water in the pool. Next, suppose you scooped up some water from the pool into a clean cup. You wouldn't be

able to see, taste, or smell the juice.

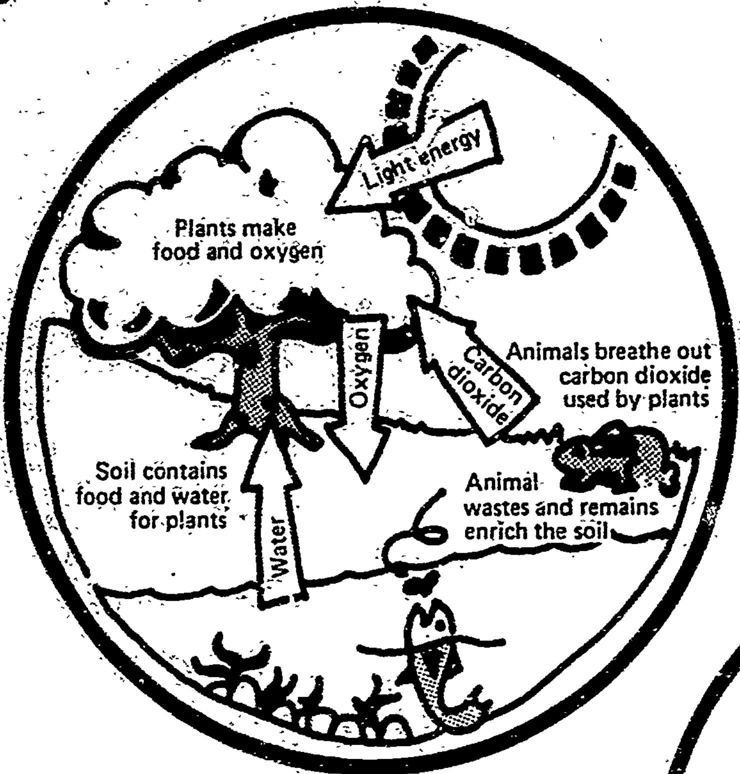
If you tried to reach a ratio of 50 parts of juice per trillion parts of water, you would have to spread your few drops of juice through 20 swimming pools.

How much is too much? In the case of orange juice, a few drops in a swimming pool is not important. But if the substance in the water were a toxic substance instead of juice, a few drops could be very dangerous.

With modern technology, scientists can now discover very, very small amounts of toxic substances — amounts as small as 50 parts per trillion — in soil, water and food.

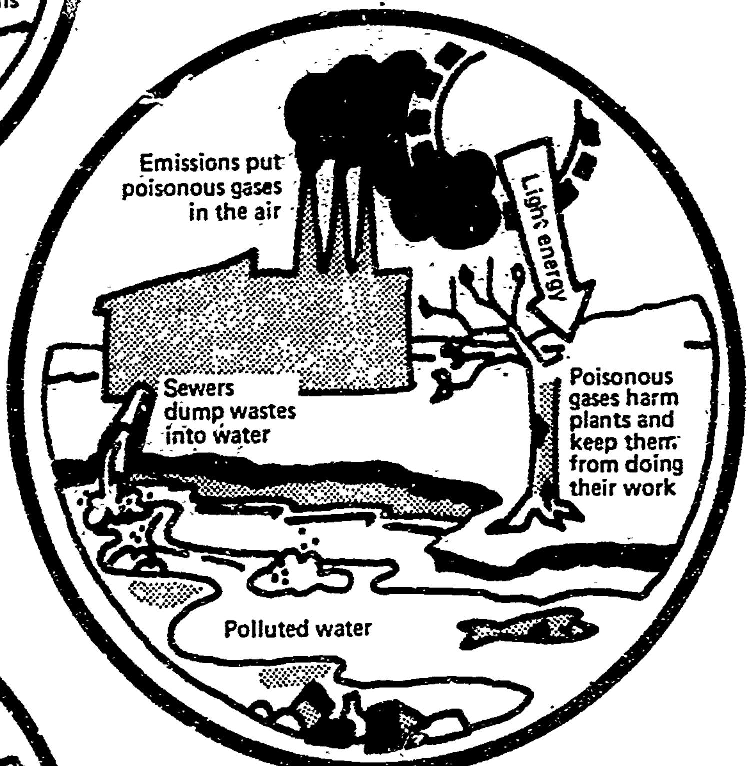
Often people say, "A little bit won't hurt." In the case of toxic substances in our water supply, even very small concentrations may be a health risk.

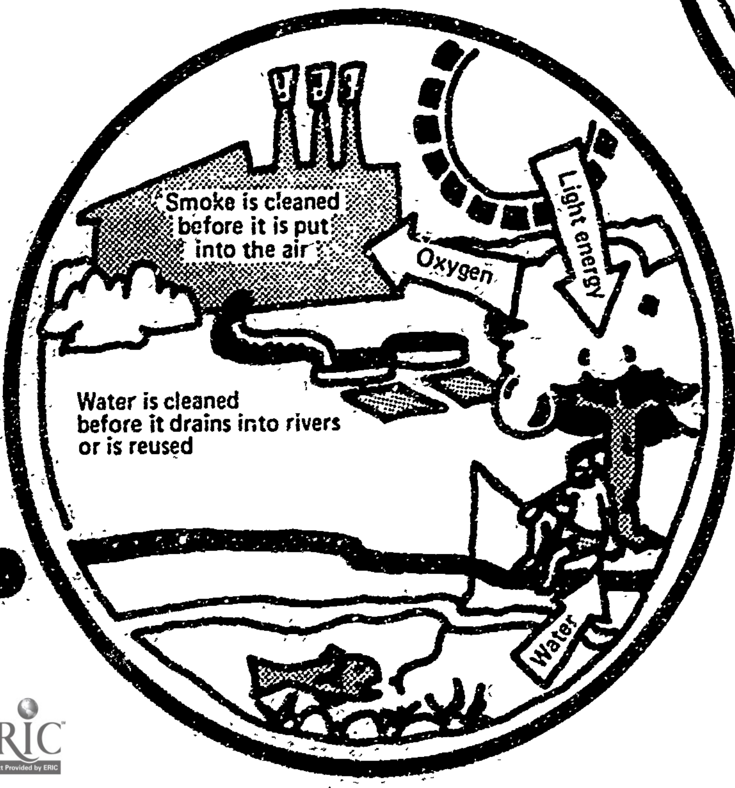
Earth's Closed System



Natural Environment

Polluted Environment





Clean Environment

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Experiment

TOXICS AND LIVING THINGS

OBJECTIVE: To find out how some substances can be toxic to living things.

MATERIALS: Two containers such as flower pots or plastic cups, two plants, soil, salt, water, measuring cup

PROCEDURE: Place soil in the containers. Put one plant in each container and place in a sunny spot. Keep the soil moist. Water one plant regularly with ordinary tap water. Water the other plant regularly with a combination of tap water and salt.

EVALUATION:

- What happens to each plant?
- What does this tell you about the effect of certain substances on living things?

Project

WATER MAKES THE HEADLINES

OBJECTIVE: To observe the daily news coverage of stories regarding clean water.

BACKGROUND: Clean water often makes the headlines, or tops a radio or television newscast. The stories may range from a city's drinking water supply being threatened from an oil spill to a citizen's group cleaning a polluted stream.

MATERIALS: Daily newspapers

EXTENSION: 1) Have students observe the daily news coverage regarding stories about water. The source can be either television, radio, or newspapers. 2) The students then write a report about the news story regarding water-related issues. 3) The entire class may want to chart how much news coverage is given to water-related issues by your local media.

Word Find

How many of the following words can you find in this puzzle? Each word may be spelled forwards, backwards, downwards, diagonally, or diagonally backwards.

L T H E H V I S C O S E T T E R T I A R Y A R A T I O N M A
E S Y R Z R I H N Y D A R R T S N D P N T D O Q R U N O R C
N U D G B G N O I T A R E A L I P O T A I L E U F F T T S I
C F R L O S L U E D D G E N E N U I S E S E D I M E E N T D
L R O O R L Z T R N T A I S A L I N A C O A E L J S U F O R
O Y L R T U O H I R J Y R P H I L P H R C K D E I S L L M A
S B O S A D T C K C L H E I F E N O B Y S E W A G E L K M I
E A G D S G F H E A I D S R S E W A G I I L N R R W O Y O N
D B I L L E S R I O I K T A O C E W R S V W A T I R P G R S
S E C O N D A R Y T R E A T M E N T U T E C B R T H I J N E
Y R A I T R Q E T I N N E I I P V Q M L V H D E N E N A O D
S Y L D S N U R D H I I J O C N I I L A W Y R O L I B N W I
T O G L Q O I E G D T R D N O S R O U L X Y I A O G A E W M
E U Y G R R F A U S H O M H N T O T V I W T I J L A R R A O
M B C A I A E J R N I L S M S T N D A Z A W O T R G O I L N
S E L F S T R N K W S H O E E D M O L L T E C X A M O C S T
E W E T L E N U I E T C S S R L E G L N E C Y M F E N O D S
W A S I T G A M M L L O R E V A N I A L R O O M S R K N L H
A S F A H O U P D O A C E E A C T N E M T A E R T A N U O J
G T W P N T C S T D N S A V T S A W O M A S R I A H G N S C
P E I A O D L P O L E K M D I R C Y C I B R R A N D I E H Y
E W L E S H O G O H N I U D O P H E A V L N A F E O C S L C
E A L R I T T Y S L O A I R N D Y N C W E T L A N D S E U L
D T T Q A E E E I A L I E A V E D H Y D R O L O A G E I C A
N E R B P I H W N Z L U P Y Z A R R C R E C U R B F D F O L
R N L T A O P V A A E M T O T O O L A A L E Z R T E I Y H R
U E M E N J O A N T U O M E O W L I C Y R L E P O R M E E E
N W S O M E L T T I E T G R M S I N I G R C Y C L E E N M S
O T M E N T L I H O Y R E T A W D N U O R G R E G G N O I O
F I A M R M U O E N C A I T R T G S A L O N E F L O T M X I
F W M O T V T N E R L T E V L R I E P O F E D W E R S R S R
I L I R M K O M D W C E A N E S C Y E R E S O U R C E S E C
A O E D S D O I W E T R L A N R A T S D R I L S L A R E V E
C L P A N D N N R P L A N T E S L G A Y N U L T S F O E O S
E T A N I M A T N O C T B H O R I N S H E T U U L L O P R I

aeration
aquifer
artesian well
chlorine
reservoir
runoff
saline
transpiration
viscosity

sediments
seep/sewage
EPA
tertiary
closed system
acid rain
environment
distillation
groundwater

contaminate
ban
conservation
ecology
pollute
treatment
wastewater
pollution
water

water table
resources
wetlands
hydrology
potable
hydrologic cycle
rain
secondary treatment
sludge

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Answers to Word Find

L T H E H V I S C O S E T T E R T I A R Y A R A T I O N M A
E S Y R Z R I H N Y D A R R T S N D P N T D O Q R U N O R C
N U D G B G N O I T A R E A L I P O T A I L E U F F T T S I
C F R L O S L U E D D G E N E N U I S E S E D I M E E N T D
L R O O R L Z T R N T A I S A L I N A C O A E L J S U F O R
O Y L R T U O H I R J Y R P H I L P H R C K D E I S L L M A
S B O S A D T C K C L H E I F E N O B Y S E W A G E L K M I
E A G D S G F H E A I D S R S E W A G I I L N R R W O Y O N
D B I L L E S R I O I K T A O C E W R S V W A T I R P G R S
S E C O N D A R Y T R E A T M E N T U T E C B R T H I L N E
Y R A I T R Q E T I N N E I I P V Q M L V H D E N E N A O D
S Y L D S N U R D H I I J O C N I I L A W Y R O L I B N W I
T O C L Q O I E G D T R D N O S R O U L X Y I A O G A E W M
E U Y G R R F A U S H O M H N T O T V I W T I J L A R R A O
M B C A I A E J R N I L S M S T N D A Z A W O T R G O I J N
S E L F S T R N K W S H O E E D M O L L T E C X A M O C S T
E W E T L E N U I E T C S S R L E G L N E C Y M F E N O D S
W A S I T G A M M L L O R E V A N I A L R O O M S R K N L H
A S E A H O U P D O A C E E A C T N E M T A E R T A N U O J
G T W P N T C S T D N S A V T S A W O M A S R I A H G N S C
P E I A O D L P O L E K M D I R C Y C I B R R A N D I E H Y
E W L E S H O G O H N I U D O P H E A V L N A F E O C S L C
E A L R I T T Y S L O A I R N D Y N C W E T L A N D S E U L
D T T O A E E E I A L I E A V E D H Y D R O L O A G E I C A
N E R B P I H W N Z L U P Y Z A R R C R E C U R B F D F O L
R N L T A O P V A A E M T O T O O L A A L E Z R T E I Y H R
U E M E N J O A N T U O M E O W L I C Y R L E P O R M E E E
N W S O M E L T T I E T G R M S I N I G R C Y C L E E N M S
O T M E N T L I H O Y R E T A W D N U O R G R E G G N O I O
F I A M R M U O E N C A I T R T G S A L O N E F L O T M X I
F W M O T V T N E R L T E V L R I E P O F E D W E R S R S R
I L I R M K I M D W C E A N E S C Y E R E S O U R C E S E C
A O E D S D O I W E T R L A N R A T S D R T L S L A R E V E
C L P A N D N N R P L A N T E S L G A Y N U L T S F O E O S
E T A N I M A T N O C T B H O R I N S H E T U U L L O P R I

ACTIVITIES FOR AND OUTSIDE THE CLASSROOM

■ Adopt part of a river or lake for the class to take care of. Plan litter cleanup trips, test the water for pollutants and tell others of the value of your adopted water area.

■ Help to plan a special program on water pollution for the school.

■ Have students find out what the drinking and water pollution laws are in your community and how well they are enforced.

■ Interview water polluters in your area for a school newspaper and describe their water pollution control problems and efforts.

■ Organize a debate in school to defend and oppose the statement: "Environmental legislation and enforcement are necessary to protect water quality."

■ Have a member of a community anti-pollution organization talk to the class about water pollution problems and solutions.

■ Draw a map of your community showing where sources of water pollution are located.

Module 5: IEPA and Environmental Laws/ Illinois Rivers Appreciation Month

Student Resources	*IEPA and Environmental Laws, the Safe Drinking Water Act and the Clean Water Act (Text)*
	Illinois Rivers Appreciation Month (Text)
	Illinois Rivers and Streams (Map)
Activities	*How Well Do You Know the Waters of Illinois? (Crossword Puzzle/Answer Key)*
	To Dam or Not to Dam (Role Playing)
	Additional Activities For and Outside the Classroom (Projects)

5

IEPA and Environmental Laws

The Illinois Environmental Protection Agency (IEPA) was created in 1970 to help solve environmental problems. Major programs at both the federal and state levels have since been enacted to deal with water quality problems. The IEPA works with other federal and state agencies, local governments, businesses and citizens on environmental problems.

The IEPA is responsible for enforcing environmental laws set by Congress and the Illinois General Assembly as well as regulations and standards established by the Illinois Pollution Control Board. Regulations are designed to protect people's health and welfare, as well as wildlife.

At the IEPA, two divisions are responsible for protecting water: The Division of Public Water Supplies and the Division of Water Pollution Control. The **Division of Public Water Supplies** makes sure that the water we drink is safe. That is not an easy job since there are nearly 2,000 public water supply systems in Illinois that deliver over 1.77 billion gallons of safe, clean drinking water every day. Most public water supplies pump water from wells for treatment and distribution to consumers.

In Illinois, the Division of Public Water Supplies guards water in several ways. The division checks plans to see that water plants are built according to standards, monitors water plant operations after construction to be sure they are properly operated and routinely checks the quality of untreated ground and surface water. The division also licenses the people who operate the plants, tests treated water for signs of contamination and provides help when emergencies occur which involve water supplies.

The **Division of Water Pollution Control** makes sure that Illinois rivers, lakes and streams stay clean. State programs make sure that sewage treatment plants treat the waste from more than 7.5 million Illinois citizens. Pollution from approximately 4,000 industrial sources must also be treated to meet state and federal requirements.

Other water pollution control programs are directed at pollution created by manmade sources. These include materials such as pesticides being washed into surface waters during storms.

SAFE DRINKING WATER ACT

This law gives the federal authority to set standards for public drinking water, and to take action to protect water still in the ground from contamination.

States which have standards at least as strict as the federal standards may take the lead in enforcing the water protection rules in their own states; *Illinois has had this authority since 1979.*

The Safe Drinking Water Act was amended (changed) in 1986 to provide more protection for drinking water. Among other things, the changes call for adding, within three years, 83 new drinking water standards for contaminants. The federal EPA must develop nationwide rules which require filtering surface water supplies by 1988, and for disinfecting both surface and groundwater supplies by 1990. All Illinois water supplies which use surface water already provide this treatment.

CLEAN WATER ACT

The Clean Water Act provides protection of all waters of the United States from water pollution. The law is jointly administered by the states and U.S.EPA.

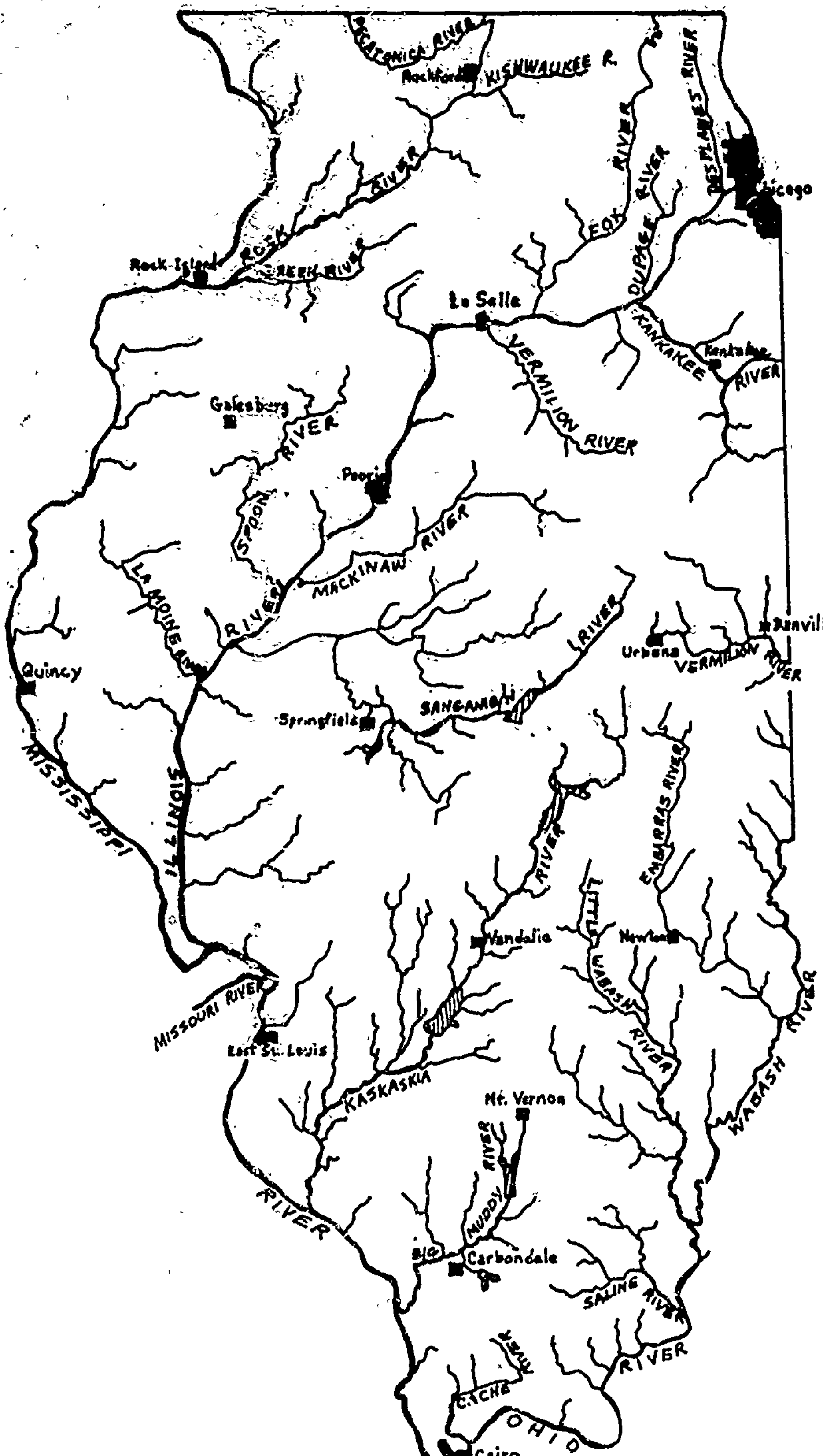
- ☐ States establish water quality standards consistent with U.S.EPA guidelines that protect aquatic life and recreational uses.
- ☐ Permits are issued by U.S.EPA or state agencies to cities and industries which limit the amount of pollution that can be released to surface waters.
- ☐ States and federal agencies sample both streams and discharges to make sure that permit limits and water quality standards are being met.
- ☐ The Act provides financial assistance to towns and cities so that they can construct sewage treatment plants to control the discharge of pollution.

ILLINOIS RIVERS APPRECIATION MONTH

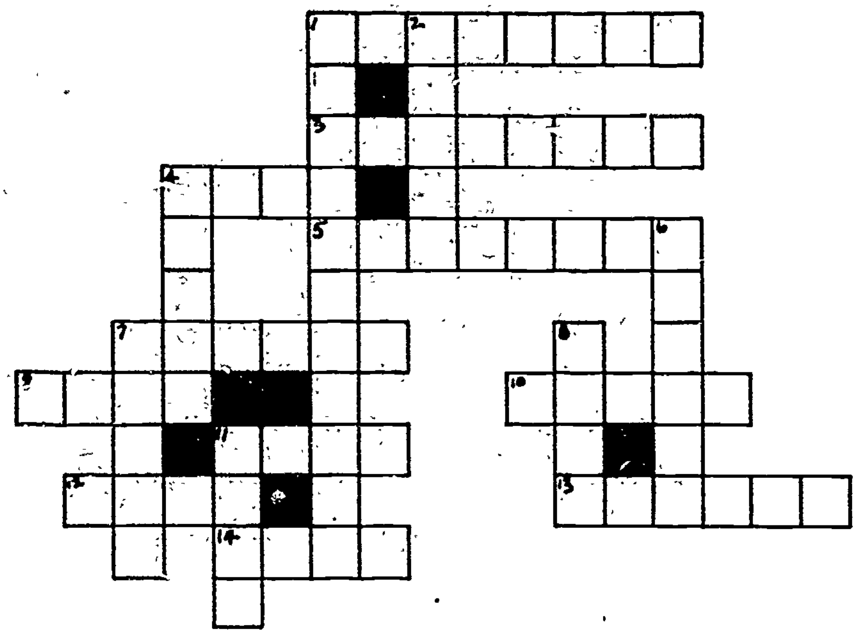
The State of Illinois has 13,000 miles of rivers and streams. The Indians and explorers used these water highways to travel throughout the state. Forts and major cities were built along these water routes. The rivers provided energy, food and transportation.

These rivers are still important today. The rivers provide habitat for fish and other aquatic organisms, areas for recreation, scenic resources, drinking water and corridors for wildlife. Each June, the Illinois Environmental Protection Agency and the Illinois Department of Conservation co-sponsor Illinois Rivers Appreciation Month. The Illinois observance is part of a nationwide effort to focus attention on the importance of our rivers.

Illinois Rivers and Streams



How Well Do You Know The Waters of Illinois?



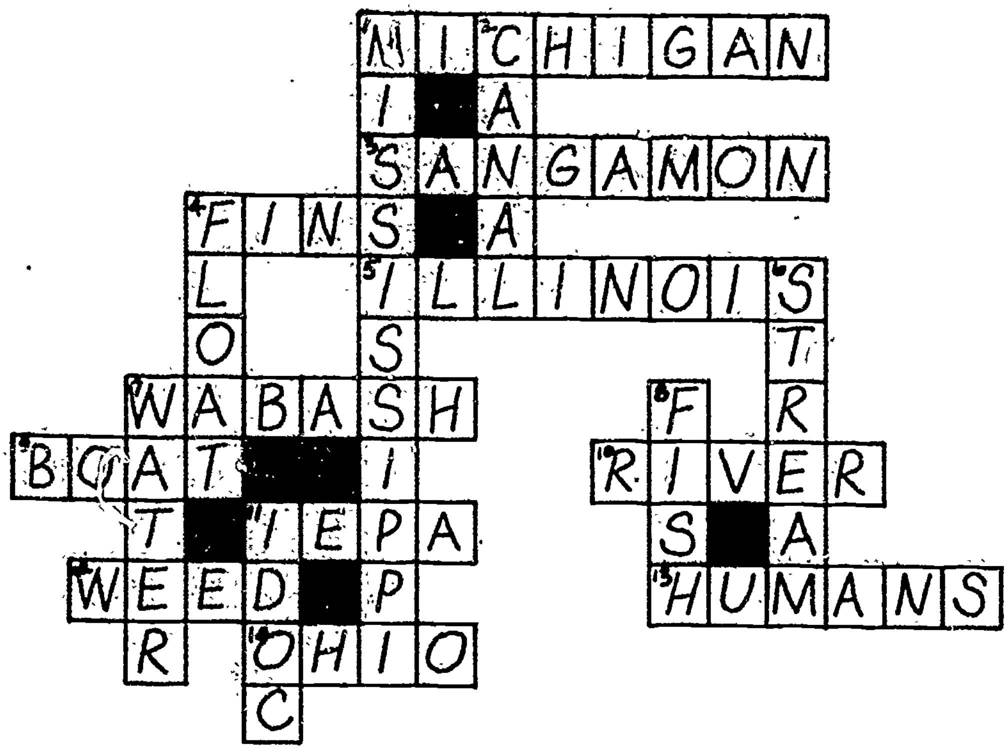
ACROSS

1. This Great Lake has a shoreline along Chicago.
3. The major river that flows through Springfield.
4. Fish use these to move through the water.
5. A major river that flows through Peoria.
7. A major river that separates the states of Illinois and Indiana.
9. Watercraft used for fishing.
10. A large moving body of water.
11. The initials of the Illinois Environmental Protection Agency, a co-sponsor of Illinois Rivers Appreciation Month.
12. When an aquatic plant becomes too numerous in a lake or river, it is often called a ______.
13. The form of animal life on the planet earth that has polluted our lakes and rivers.
14. A major river that separates the states of Illinois and Kentucky.

DOWN

1. The longest river in the United States.
2. A waterway that has been dug.
4. A lifejacket will ________ on the water.
6. A moving body of water smaller than a river.
7. The chemical formula is H_2O.
8. An aquatic animal with fins.
11. The initials of the Illinois Department of Conservation, a co-sponsor of Illinois Rivers Appreciation Month.

Answers to Waters of Illinois Crossword Puzzle



66

Role Playing

TO DAM OR NOT TO DAM

OBJECTIVE: Students will be able to evaluate potential positive and negative effects from constructing a dam on a river.

METHOD: Students role play individuals representing differing perspectives and concerns related to a complex issue.

BACKGROUND:

Hypothetical situation: The town of Rocksburg, population 900, is located along the scenic Jones River approximately 60 miles from the closest big city. The mayor and city council of the big city have proposed that a dam be constructed two miles upriver of Rocksburg. In the Environmental Impact Statement written by the city engineers, the following information was identified.

The dam would meet the area's electrical power demand for 10 or more years in the future. It would provide some water for irrigation and would help with flood control problems down river.

Construction would be of rock-earth fill, 75 feet high and 300 feet across. Seven miles of river would be turned into a lake.

The dam construction would take five years to complete and would employ over 2,000 workers. After the dam was finished, approximately 150 workers would be required to keep the plant running.

Wildlife would be affected in the following ways:

- ☐ 20 percent loss to the deer herd that browses the lands alongside the river do to lost forage
- ☐ 20 percent loss to small mammals living in the river valley due to loss of habitat
- ☐ 20 percent loss to the area's songbird population due to lost river bank nesting sites
- ☐ blockage of the upstream and downstream movement of fish that live in the river due to the creation of the lake and dam
- ☐ reduction of the area's wintering population of bald eagles due to the loss of riverbank trees where the eagles commonly roost while feeding on the fish: the eagles winter in the area and disperse to other areas in and out of the state to nest
- ☐ development of suitable habitat for bass, carp and other spiny-ray warm water fish due to the creation of the lake; the lake water tends to be warmer than the flowing river water.
- ☐ loss of 10,000 acres of prime timber growing land and wildlife habitat

The people in Rocksburg are concerned about the problems and benefits from the number of people that would come to their town during and after the construction of the dam. They are concerned about effects on schools, sewage disposal, roads, homesites, property values and the rural atmosphere, as well as police, fire and hospital emergency capacities. They see some potential benefits from the development, such as new recreation opportunities for the people of Rocksburg and the city which is only about an hour away (water skiing, sailboarding, motorboating, swimming, fishing, camping, picnicking, and other lake-related sports).

Other impacts could include:

- ☐ loss of drinking water quality locally and in the metropolitan area
- ☐ flooding of Native American Indian archeological sites
- ☐ cultural changes for local Native American tribal people who have fished the river for generations
- ☐ water for irrigation at a lower monetary cost
- ☐ potentially less (monetarily) expensive power when compared to other forms of power production, e.g. nuclear, coal, oil, fossil fuels
- ☐ potentially more (monetarily) total power bills that may be necessary to pay for construction of the dam
- ☐ loss of seven miles of prime whitewater; private and commercial raft, kayak and canoe trips would be gone

MATERIALS: Role playing cards

Roles:

1) *Five people* chosen as members of the *County Council.*
2) *"Rick" Ulture:* a representative of the local farmers' coalition interested in the irrigation potential of the dam.
3) *Lotta Power:* a lobbyist for the municipal electrical power company interested in developing the dam.
4) *Rob or Marta Kanu:* kayaker concerned with the loss of the whitewater stretch for canoeing and kayaking.
5) *Sam N. Fish:* a local sporting goods store owner and avid fisherman concerned with the loss of migration routes of the fish on the river.
6) *Dan D. Lion:* the president of the "Save Our Native Plants and Wild Animals" organization.
7) *Pat "Pottery" Brusher:* an archeology professor from the local university who has done extensive research on the archeological sites of Indian fishing camps along the river.
8) *Lynn Dripper:* the director of the muncipal water quality authority responsible for providing quality drinking water for the city, and attracted

to the dam's potential for providing a reservoir of high quality water usable during long hot summers.

9) *H.M. Owner:* a representative for all homeowners in the river valley below the dam who would like to see more flood control.

10) *Bobbie Lawkeeper:* the local Rocksburg sheriff concerned about maintaining police protection, peace, health and safety with only a one person staff as the sole legal authority in the region.

11) *T.M. Burr:* the owner of a lumber company whose land would be inundated by the dam.

12) *I.M. Floaten:* an owner of a whitewater rafting company who uses the river for commercial rafting. Concerned about the loss of the "best seven miles of the river." I.M. argues that the best rapids would be submerged by the lake.

13) *"Sky" Soarer:* the president of the local bird club who has organized eagle-watching trips to the river every winter for the last 15 years.

14) *Sam Slalom:* an avid water skier who sees the new lake as a real boon to skiing interests.

15) *Velma or Virgil Vigil:* a local representative of the gray panthers, a group of retired people who are concerned about any rise in power bills.

16) *Boater Cartop:* an older fisherperson who enjoys throwing the boat on the tip of the car and putting in at the closest float spot — especially lakes!

17) *Marshal or May Flyfisher:* a long-time resident who champions the purity of fly fishing and insists on pristine habitat, noting the necessity of white water riffles.

18) *Col. "Bull" Winkle:* the president of "More Moose Now" who believes that with the lake behind the dam, more moose habitat will be created.

19) *Lap Larson:* the president of W.O.W. (Watch Our Waves).

20) *Cy or Sy N. Tist:* a respected biologist who is prepared to testify about potential effects on wildlife from the building of the dam.

21) *O.L. Slick:* a salesperson for motor boats, water skis and other recreational equipment.

22) *Forest or Park Site:* a trained forester who has worked in the woods in the area for more than 50 years.

23) *Running Waters:* a tribal leader who is concerned about loss of native heritage from flooding the region for the dam.

24) *E. Conomy:* a local businessperson who is concerned about the long-range business potential of the area.

25) *C.D. Minium:* a wealthy land developer who has architects working on designs for lakeside condominiums and resort homes.

NOTE: ***Some students have dressed for their roles to heighten the dramatic quality of the experience.***

PROCEDURE: 1) Provide students with the background information. Generate an initial discussion with them about some of the possible costs and benefits from the construction of this dam, considering it from a variety of perspectives.

2) Ask each student to choose the role of an individual to become or represent for the purpose of this activity — or assign roles randomly. Examples of roles are included. Establish a balanced variety of roles with people having conflicting values and concerns relating to the potential impacts of this dam construction. NOTE: *Teachers have copied the role descriptions and cut them apart to pass out to students.*

3) Ask students to prepare for their role, developing a short position paper for use as background for the dramatization of their role.

4) Arrange the classroom to represent a meeting room for the county-council in the area in which the town of Rocksburg is located. Students will role-play their position and make a presentation to the five-member Rocksburg County Council. This council will ultimately make a recommendation to the F.E.R.C. (Federal Energy Regulatory Commission) on a siting permit for the dam.

6. Following the council's decision, have a brief class discussion to summarize the "pros" and "cons" that emerged from the students' presentations. Identify and list the benefits, if any, and costs or liabilities, if any, as a result of building the dam. Include effects on people, plants and animals. The list of pros, cons and effects can be listed visually on a chalkboard.

7. After the role play and class discussion, ask each of the students to write a brief essay describing his or her own personal recommendation for whether or not to build this dam. The students might expand their position papers, or "start from scratch" in writing their essays.

EXTENSIONS: 1) Change roles and conduct the council meeting again. Note any differences in the results, as well as your perceptions of the process and experience.

2) Find out if there are any proposals to create new dams or any other proposals that will affect wildlife habitat in your region. If so, investigate the "pros and cons" of one or more of these proposals, from your perspective.

3) Is there a dam in your area? Visit it. Find out about its effects on people, plants and animals — both positive and negative, if any.

EVALUATION:

- Name two or more possible benefits to people if a dam were constructed on a river.
- Name two or more possible negative consequences to people if a dam were constructed on a river.
- Describe possible positive and negative effects on a variety of different kinds of plants and wildlife under each of the following conditions if these conditions existed as a result of the construction of a dam; water levels in the area below the dam are low for at least part of the year; water going over the dam drops a long way; very cold water is taken from the bottom of the dam and released into the river below.

ADDITIONAL ACTIVITIES FOR AND OUTSIDE THE CLASSROOM

- On a large map, find and identify the major rivers in Illinois.

- Plan a boat trip to New Orleans. Starting from your school, list the names of all the creeks, streams, lakes and rivers you would use on your trip to New Orleans.

- Cleanup litter from your schoolyard, neighborhood, or public park. Litter is often washed by rains into storm sewers that then enter local waterways.

- Organize a recycling program in your school. What we recycle does not get buried in a landfill, or washed into a stream. (For additional information on organizing a recycling program, write the Illinois Environmental Protection Agency.)

Additional Classroom Activities

Activities *Wheel of Fortune*

Jeopardy

Aquatic Times

WHEEL OF FORTUNE

OBJECTIVE: To help students learn environmental and water terms

MATERIALS: Blackboard, chalk, eraser, a Wheel of Fortune spinner, Dictionary of Environmental and Water Terms (Note: The dial should have different dollar value sections, and "lose a turn", "free spin" and "spin again" sections.)

PROCEDURE:

1) Divide the class into teams.

2) Select a word from the Dictionary of Environmental and Water Terms. Draw the number of spaces on the blackboard that correspond to the number of letters in the word.

3) A member of the first team spins the wheel and guesses a letter in the word. If the guessed letter appears in the word, write the letter in the correct blank, and the team wins the dollar amount of the spin.

4) If the letter is not in the word, the next team spins the wheel.

5) Each time a team correctly guesses a letter, they may try to complete the puzzle. If the team guesses correctly, they win the money they have collected in the round. If the team guesses incorrectly, the next team continues play.

6) The team with the most money at the end of the play period wins.

JEOPARDY

OBJECTIVE: To help students learn environmental and water terms, and drinking water and wastewater treatment milestones.

MATERIALS: Dictionary of Environmental and Water Terms, Drinking Water
Milestones handout

PROCEDURE:

1) Determine a point value to each question. Decide the length of each round.

2) Divide the class into teams.

3) Read an ***answer*** from the Dictionary of Environmental and Water Terms or Drinking Water Milestones handout. For example, "The first country to use chlorine to kill germs in their drinking water supply."

4) The first team to signal tries to give the correct ***question***. For example, "What is Belgium?"

5) The team with the correct answer is awarded the point value of the question. Any team that answers incorrectly loses the points of the question. *Note: A team answer must be in the form of a question to be a correct answer.*

6)The team with the most number of points at the end of the time period wins.

AQUATIC TIMES

OBJECTIVES: Students will be able to: 1) identify a diversity of issues related to aquatic organisms and habitats; and 2) develop their own opinions concerning some issues involving aquatic life and habitats.

METHOD: Students investigate, write and produce a newspaper that features aquatic information and issues.

BACKGROUND: In any classroom there is a wide range of learning styles and skills among the students. The production of a newspaper requires an array of skills that include art ability, graphic sense, design capabilities, creative writing, composition, research and decision making. This means that such an effort has a high likelihood of addressing many of the diverse skills possessed by various class members.

This activity provides an opportunity for the students to coordinate newspaper production with information, issues and recommendations about aquatic organisms and their habitat with others.

The major purpose of this activity is to familiarize students with a range of aquatic-related topics and issues.

MATERIALS: Library resources: current nature magazines (*Ranger RicK*, *National Geographic*, etc.); writing materials; Optional: typewriters, cameras, tape recorders, computer.

PROCEDURE: 1) Using an actual newspaper as a model, discuss the various parts of a newspaper. Help the students recognize that in addition to news articles, many special interest departments exist in most newspapers. Comics, sports reports, editorials, commentary, home making articles, want ads, political cartoons, food and nutrition features, entertainment information, business columns, weather predictions, daily horoscopes, obituaries and many other sections are available. Also draw attention to advertisements. Ask each student or team of students to choose one section to plan and write. NOTE: *With younger students, you may not want to spend time looking at actual newspapers. The concept of identifying and reporting news can still apply. The whole activity could even be modified to be a television news broadcast, where the students each help to report orally.*

2) Begin the research phase, asking the students to gather information and ideas for their chosen section. Tell them that whatever they compile has to relate to aquatic animals and plants, aquatic habitats, or aquatic-related issues. Show the students how to properly acknowledge and credit any sources they use. Each section should include a combination of information and the students' opinions, based on what they learn through their research.

NOTE: *If using the optional materials, familiarize the students with any resources they can use such as the tape recorders, word processors, software, cameras, etc.*

3) Try to set the stage for both playful and serious reporting.

4) Once the information accumulates and writing begins, encourage the students to share their work with each other. In this way, interests can merge and different talents can be called on. Keep the students on track, making sure their writing is accurate even though they may have chosen humor or satire as their approach.

5). When enough work is completed, begin the production phase of the paper (or preparation for the news broadcast). At this point artwork can be done to accompany the stories. The artwork can be in color or black and white and can involve computer graphics. If possible, the stories should be typed or written neatly in a specified column format (3 1/2 or 4 inches wide works well).

6) The next step is the layout and design. A small group should be assigned the responsibility, but with input from everyone.

7) Once the newspaper is complete, you may investigate the possibility of having copies made for each child. Most communities now have fast copy facilities that can print oversize papers. (It might be well to check ahead of time to be sure the format can be copied.)

8) Culminate the activity with a discussion of each article or feature, emphasizing what can be learned about aquatic life and habitat from its content. Circulate the finished newspaper — for example, by posting copies on school bulletin boards!

EXTENTIONS: 1) Have an aquatic poster contest. 2) Establish a current events corner about wildlife! 3) Develop aquatic advertisements based on a policy for accepting advertisements for products or services that are beneficial to aquatic environments. 4) Convert the newspaper to a video news format. 5) visit a local newspaper; offer them use of any of the students' articles for their use.

EVALUATION:

Name three issues involving aquatic animals, aquatic plants, or aquatic habitats. Give some information and your opinion concerning each issue.

ADDITIONAL EDUCATIONAL MATERIALS ON THE ENVIRONMENT

American Water Works Association
6666 W. Quincy Avenue
Denver, Colo. 80235
(303) 794-7711

Association of Illinois Soil and
Water Conservation Districts
3085 Stevenson Drive, Suite 305A
Springfield, IL 62703
(217) 529-7788

Illinois Department of Conservation
600 North Grand Ave. West
Springfield, IL 62706
(217) 785-8774

Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, IL 62706
(217) 782-5562

Dr. Cliff Knapp
Outdoor Education Graduate Studies
Northern Illinois University
Box 299
Oregon, IL 61061
(815) 732-2111

Project WILD
Salina Star Route
Boulder, Colo. 80302
(303) 444-2390

Don Roderick
Project WILD Co-Director
Illinois State Board of Education
100 North First Street
Springfield, IL 62777
(217) 782-2826

Water Pollution Control Federation
601 Wythe Street
Alexandria, VA 23314-1994
(703) 684-2400

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(Materials may be taken directly from reference.)

Appendix 16

END

U.S. Dept. of Education

Office of Education
Research and
Improvement (OERI).

ERIC

Date Filmed

March 29, 1991